

Low Impact Development LID

For Developers and Planning Boards

- * Effective Site Design**
- * Natural Stormwater Management Practices**

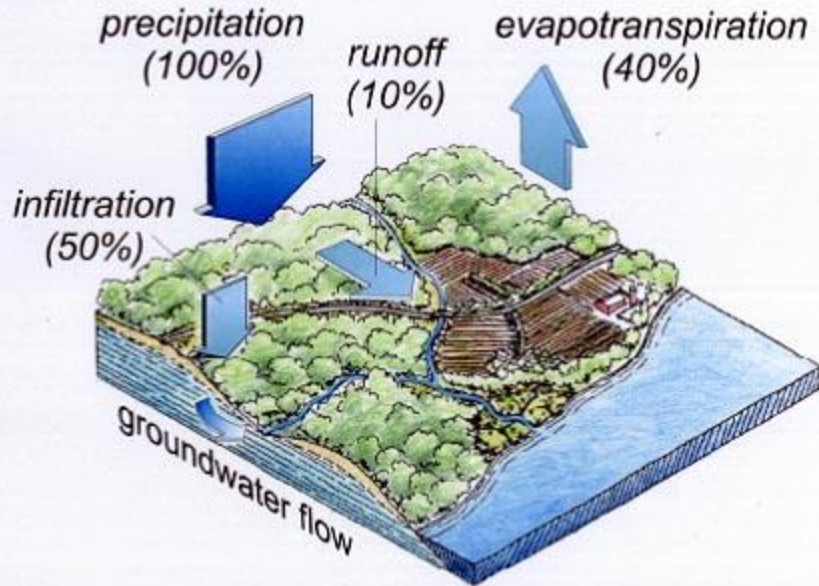


Smart Growth / Smart Energy Toolkit



The Problem

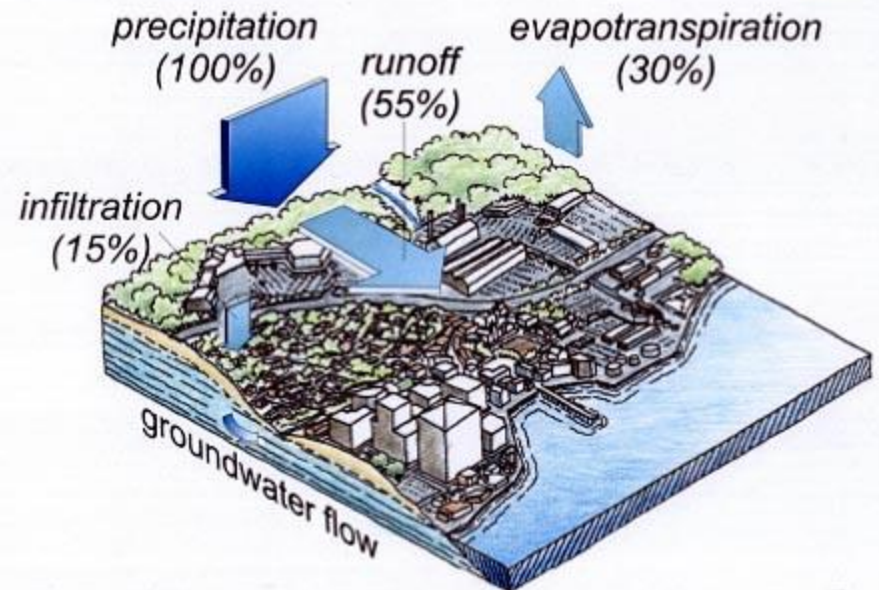
Conventional Development



Loss of natural land or open space
Depleted drinking water supply
Reduced quantity and quality of water resources
Increased infrastructure costs & maintenance

The Solution

Smart Development



Less land clearing and grading costs
Reduced infrastructure costs
Protection of regional water quality
Reduced stormwater runoff

“Conventional” Planning & Design



- Style of suburban development over the past 50 years
- Generally involves larger lots
- Clearing and grading of significant portions of a site
- Wider streets and larger cul-de-sacs
- Enclosed drainage systems for stormwater conveyance
- Large detention ponds

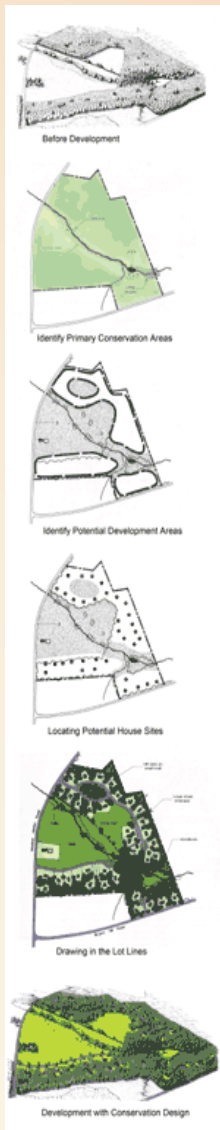
Site Design Planning Process



- #1 AVOID IMPACTS** – Preserve Natural Features and Use Conservation Design Techniques
- #2 REDUCE IMPACTS** – Reduce Impervious Cover
- #3 MANAGE IMPACTS** – Utilize Natural Features and Natural Low-Impact Techniques to Manage Stormwater

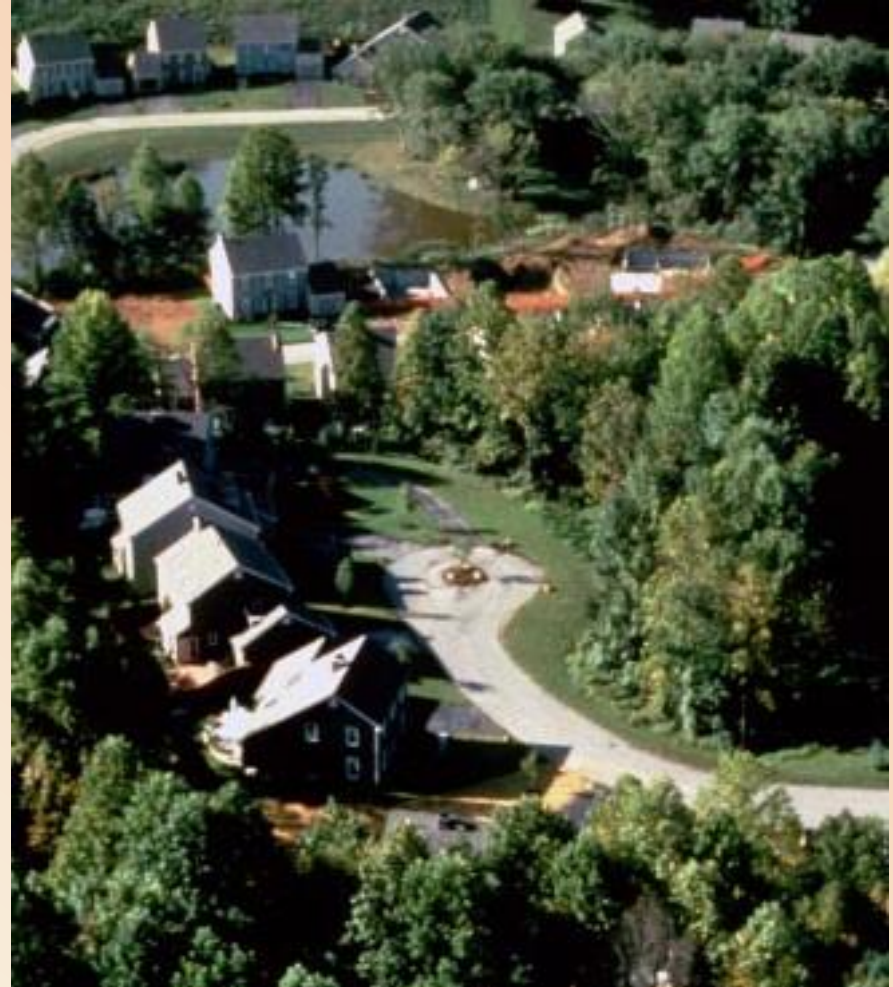
LID Site Design

- Conservation of natural hydrology, trees, and vegetation
- Minimized impervious surfaces
- Dispersal of stormwater runoff
- Conservation of stream & wetland buffers
- Ecological landscaping

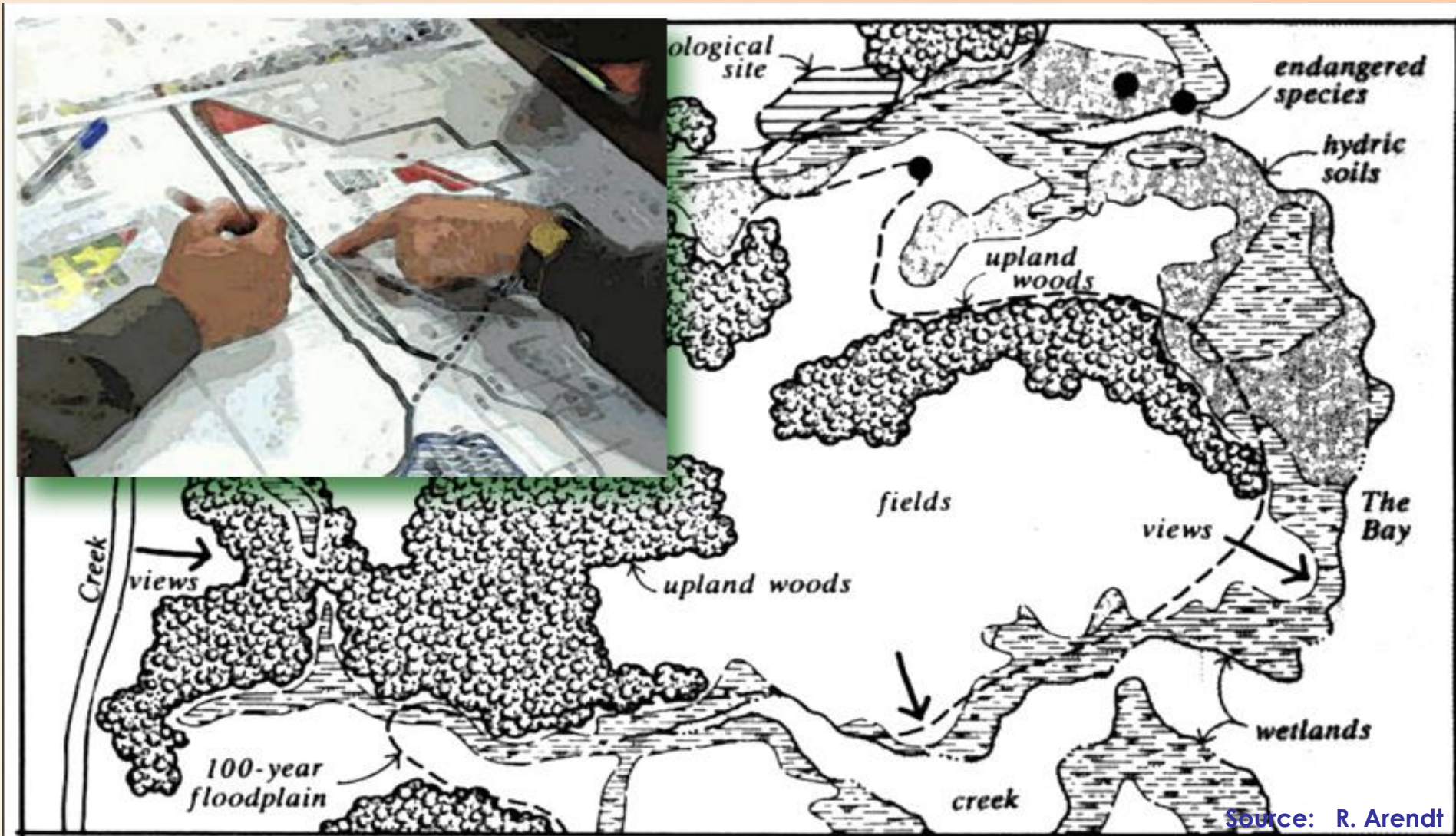


Site Design Practices

- Reduce storm pipes, curbs and gutters
- Preserve sensitive soils
- Cluster buildings and reduce building footprints
- Reduce road widths
- Minimize grading
- Limit lot disturbance
- Reduce impervious surfaces

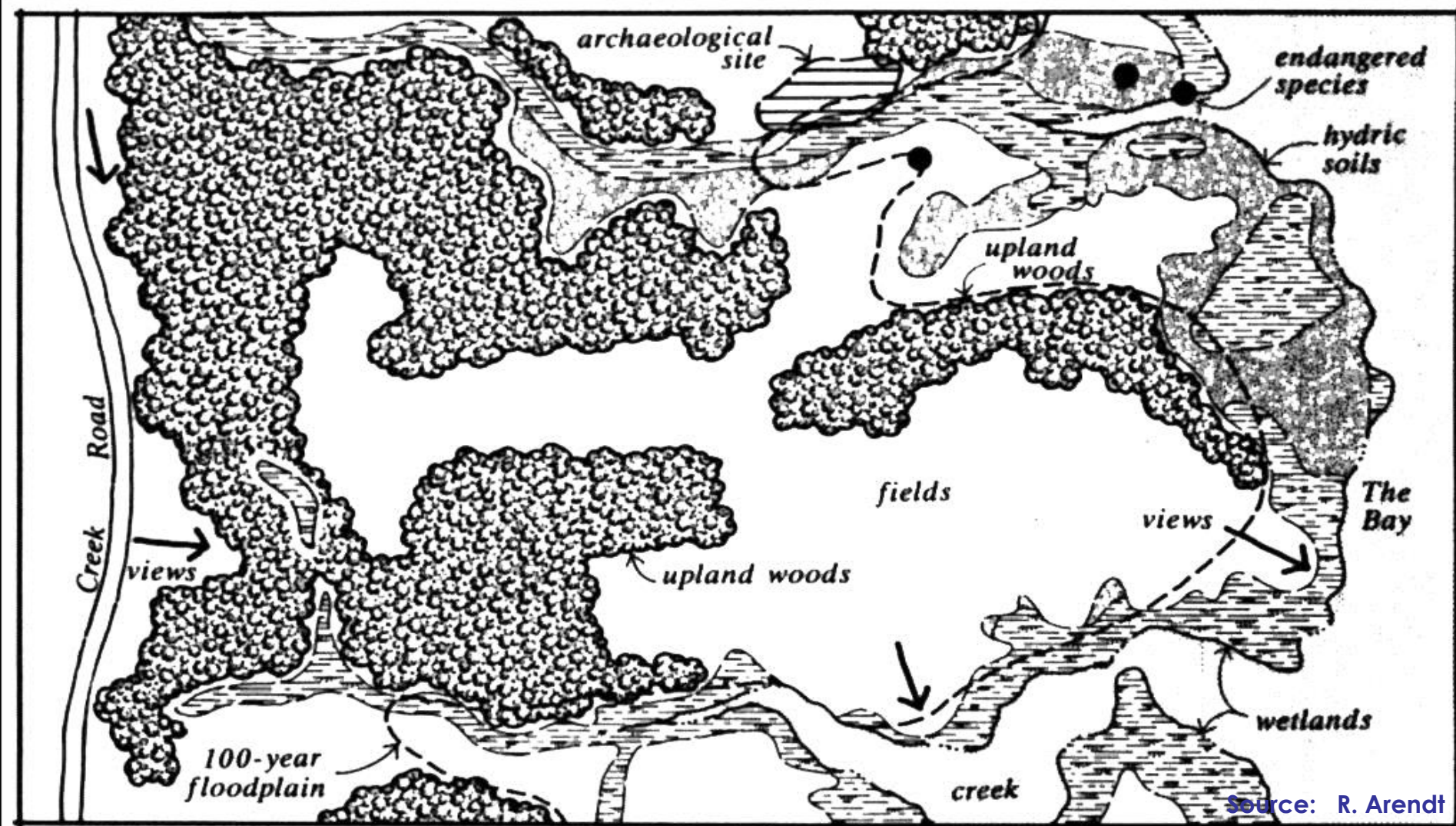


The standard planning process involves four-steps, after the yield is established.



Source: R. Arendt

1. Identify conservation value areas on the site such as wetlands, significant trees or tracts of forest, steep slopes, habitat, cultural resources or buffer zones. Remove these from the “developable area”.

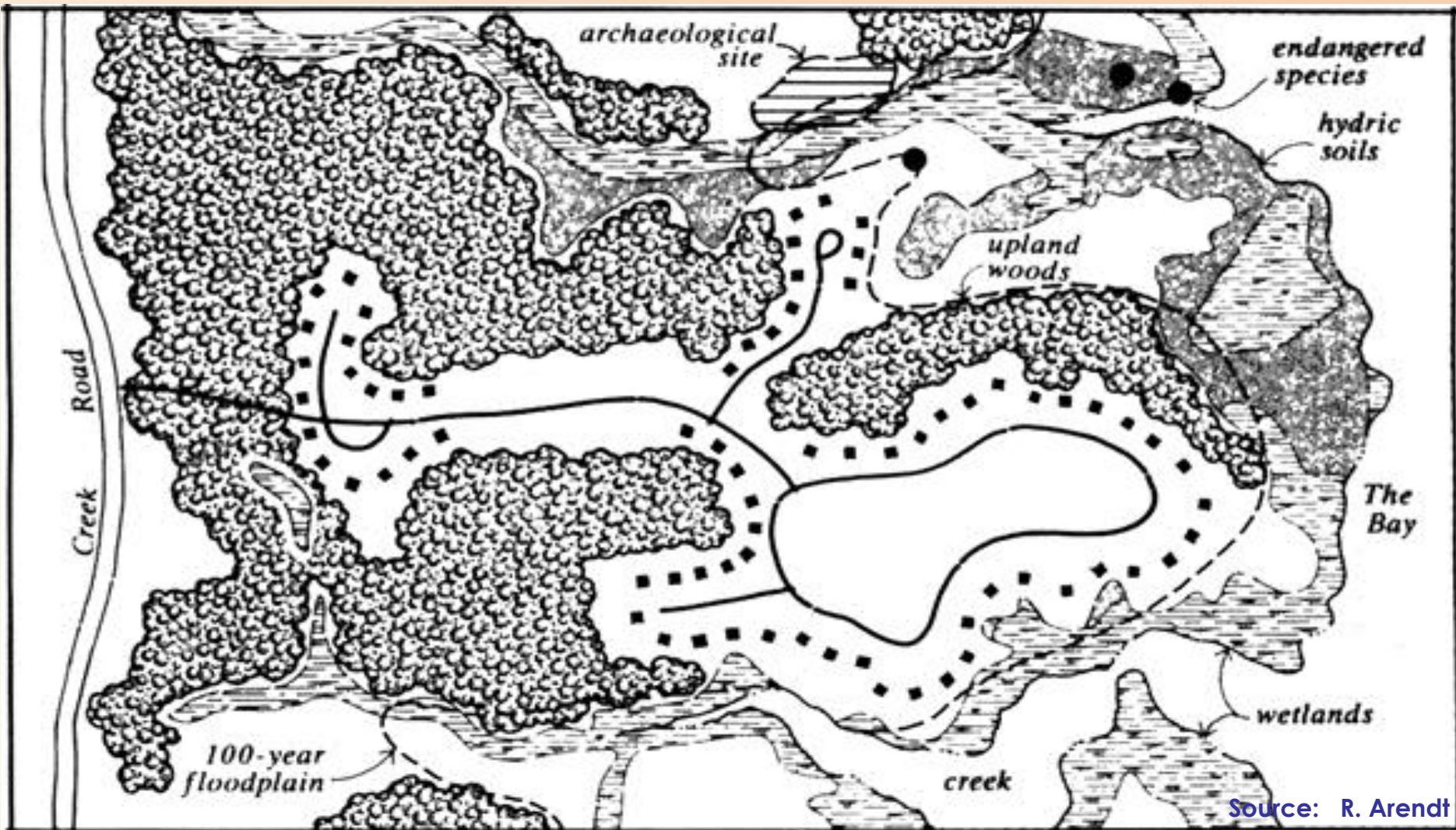


Source: R. Arendt

2. Place houses in the remaining area in a way that would maximize residents enjoyment of protected areas by providing access to open space and preserving views.

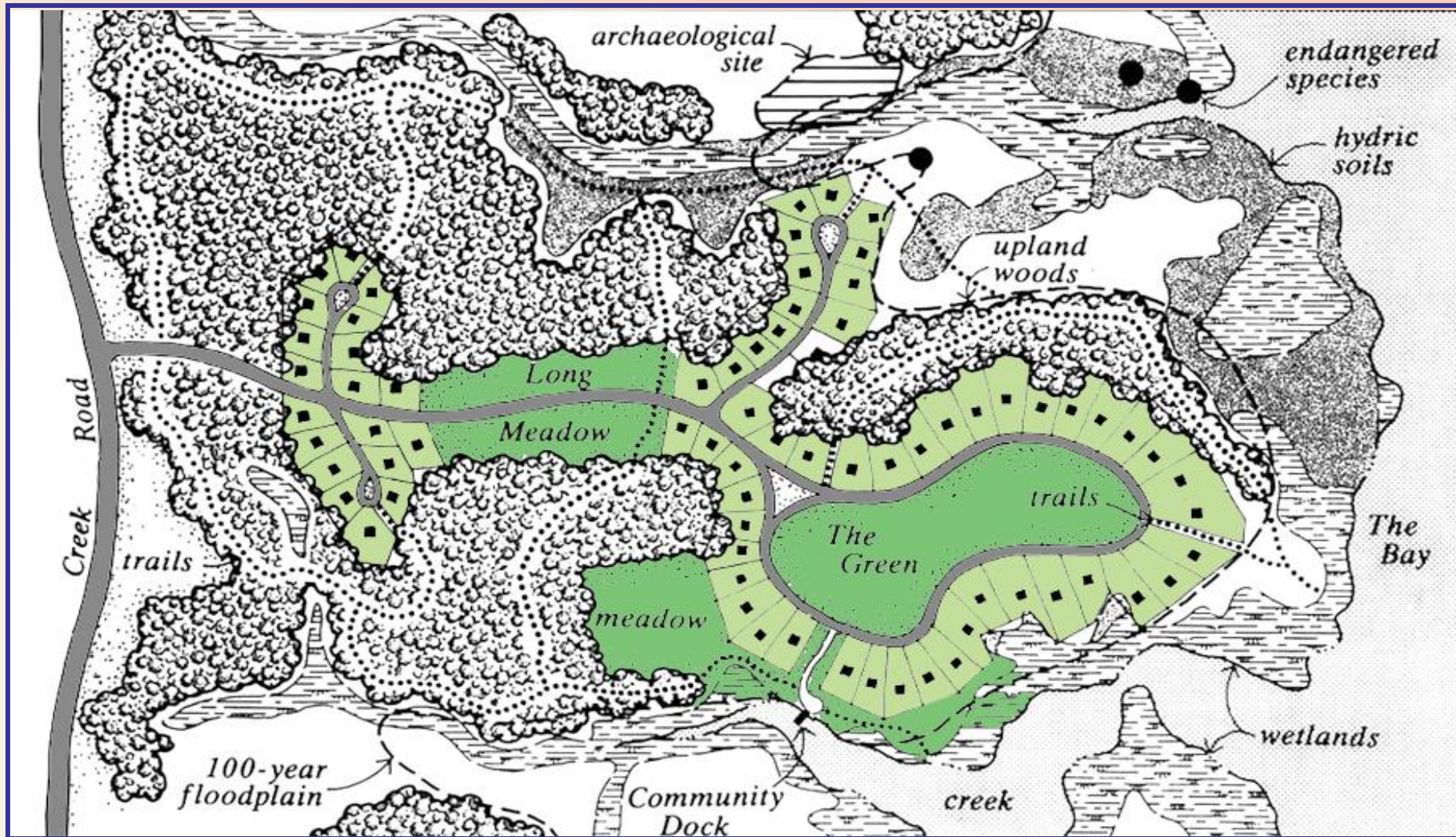


3. Align roads and trails on the site to provide pedestrian and vehicle access and maximize stormwater management options.



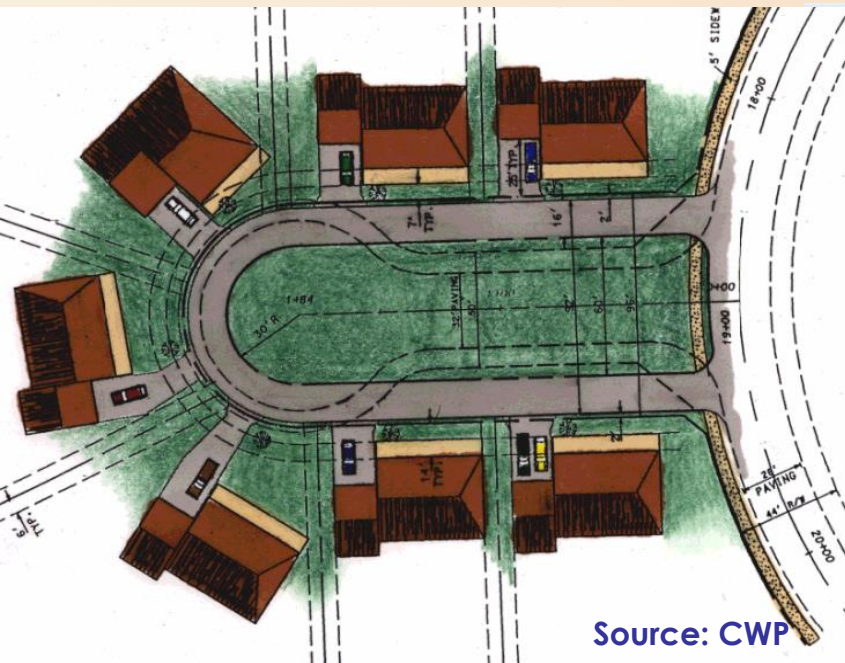
Source: R. Arendt

4. Draw lot lines around the homes.



Better Site Design on Roadways and Driveways

- Narrower streets
- Alternative cul-de-sacs
- Shared driveways



Source: CWP



Source: City of Portland, OR



Source: R. Claytor

Wide Street



9 houses

\$ 40,400 to repave

\$4,500/house

Narrow Street

A photograph of a narrow residential street lined with trees. The trees have vibrant autumn foliage in shades of yellow, orange, and red. The street is paved and leads into the distance. The scene is captured from a low angle, looking down the street.

14 houses

\$ 24,200 to repave

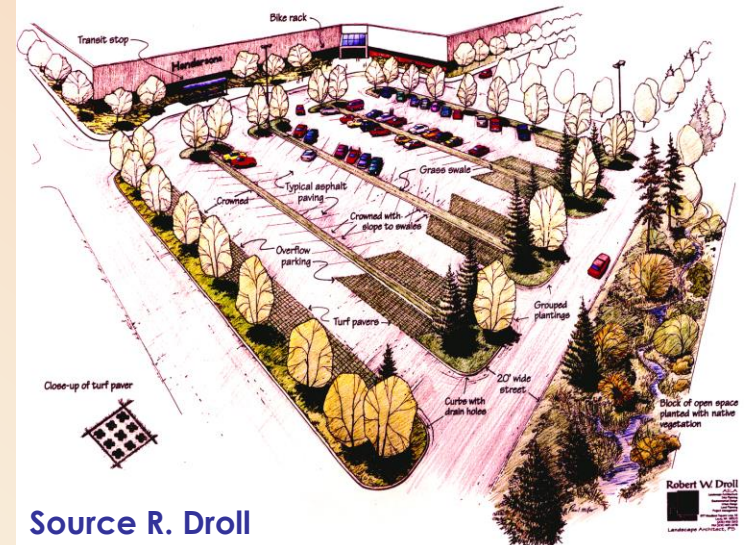
\$1,700/house



Conventional Parking Lot Design

Better Parking Lot Design

- Incorporate green strips and buffers
- Create multiple small lots
- Reduce requirements near transit
- Allow shared parking
- Require compact spaces
- Set parking maximums
- Alternative permeable pavers in overflow areas



Source R. Droll

Better Parking Lot Design



LID Stormwater Techniques

- Rain Barrels and Cisterns / Water Re-use
- Stormwater Planters, Tree Planting
- Permeable Paving
- Open Channels
- Bioretention
- Stormwater Wetlands
- Green Rooftop Systems
- Vegetative Buffers
- Infiltration



Rain Barrels and Cisterns

Runoff Reduction & Water Conservation

- Downspouts directed to tanks or barrels
- 50 -10,000 gallons
- Excess diverted to drywell or rain garden
- Landscaping, car washing, other non-potable uses



Rain Barrels and Cisterns



Source: <http://www.rdrop.com/users/krishna/rainwatr.htm>



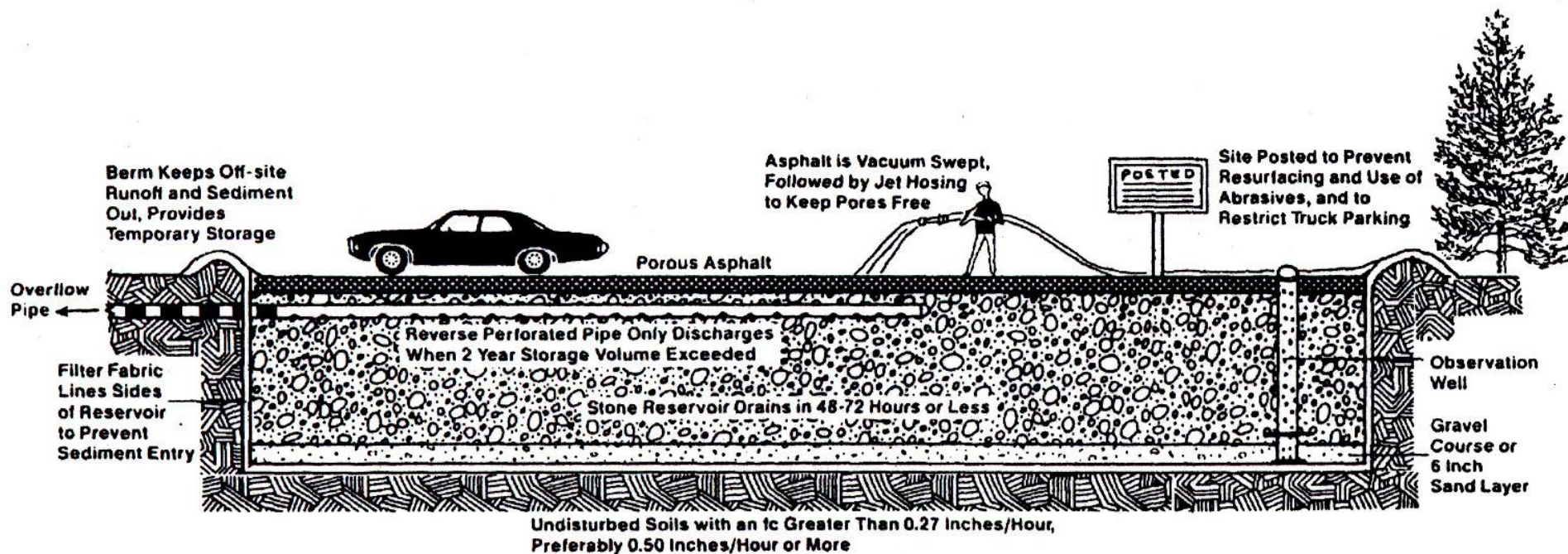
Dry Well Infiltration of Roof Runoff



Disconnection of Rooftop Runoff to Vegetated Swale



Permeable Pavement



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Permeable Pavement @ Work



Typical Applications



Smart Growth / Smart Energy Toolkit

Low Impact Development



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Low Impact Development

Vegetated Swales

Conveyance, Treatment, Infiltration

- Roadside swales (“country drainage”) for lower density and small-scale projects
- For small parking lots
- Mild side slopes and flat longitudinal slopes
- Provides area for snow storage & snowmelt treatment





Open Vegetated Channels

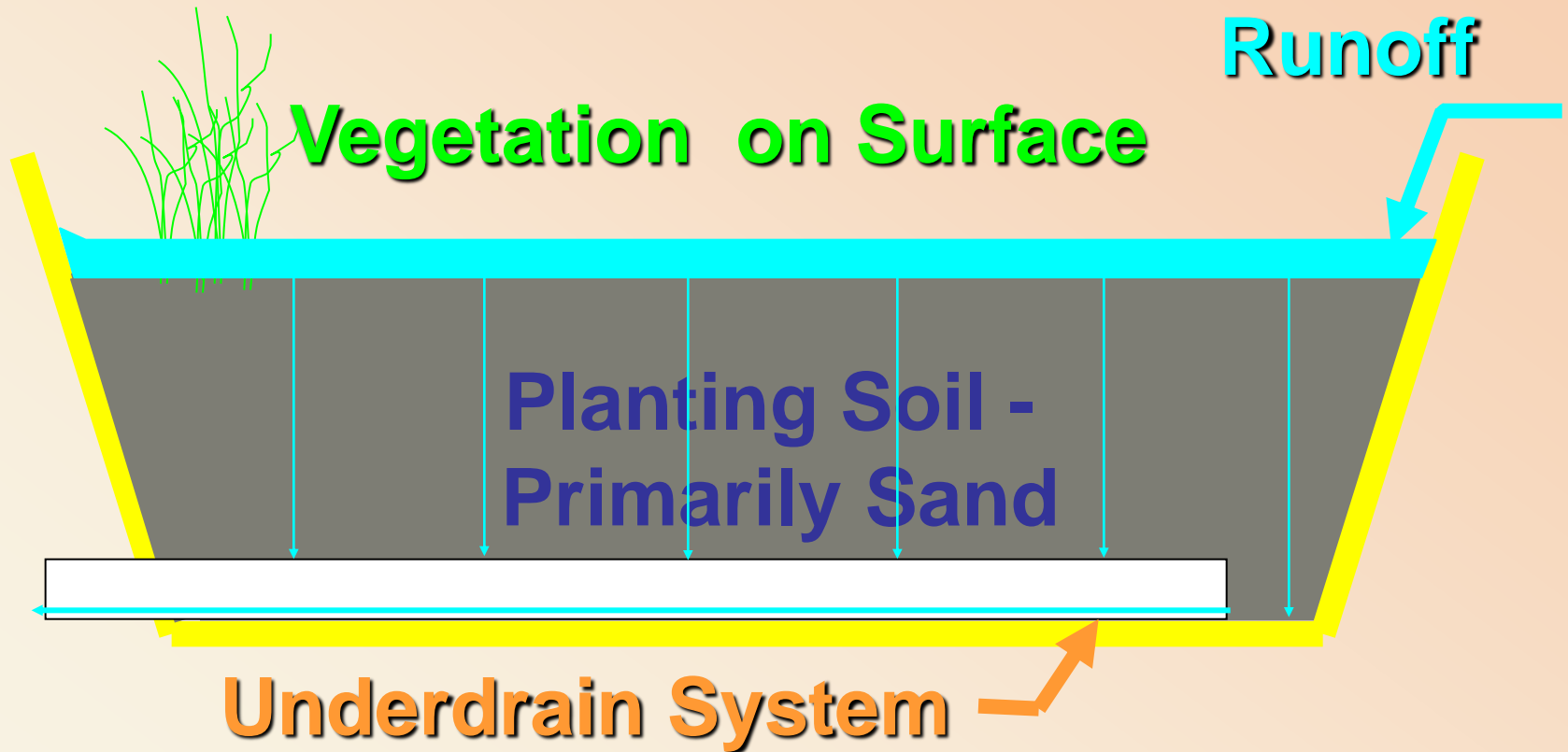
Open Vegetated Channels





Rain Gardens/Bioretention

Bioretention Schematic



Application of Bioretention

- Can be applied to a wide range of development
- Compatible with commercial landscaping needs
- Utilizes existing open space
- Economical for small sites (1 acre or less)
- Parking lot runoff (perimeters, traffic islands, & swales)
- Median strips
- Residential “Rain Gardens”
- Reduce need for storm drain pipe



Bioretention Applications

- Parking lot islands
- Median strips
- Residential lots
- Office parks



Source: City of Portland, OR



Source: Larry Gavin



Source: LID Center

Bioretention Applications

- Urban retrofits
- High-density areas





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Low Impact Development

Vegetation Management is Important



Planting Soil and Mulch

- Loamy Sand to a Sandy Loam
 - 80 % sand
 - < 20 % silt
 - < 5 % clay (some say less than 2% clay)
- Well aged graded compost (25% of soil mix)
- Well aged, aerated hard-wood mulch (aged 6 months, if possible)



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Low Impact Development



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Low Impact Development



Vegetated Filter Strips

Pretreatment and Attenuation

- Mild vegetated slopes
- Adjacent to small parking lots and roadways
- Another opportunity for snow storage

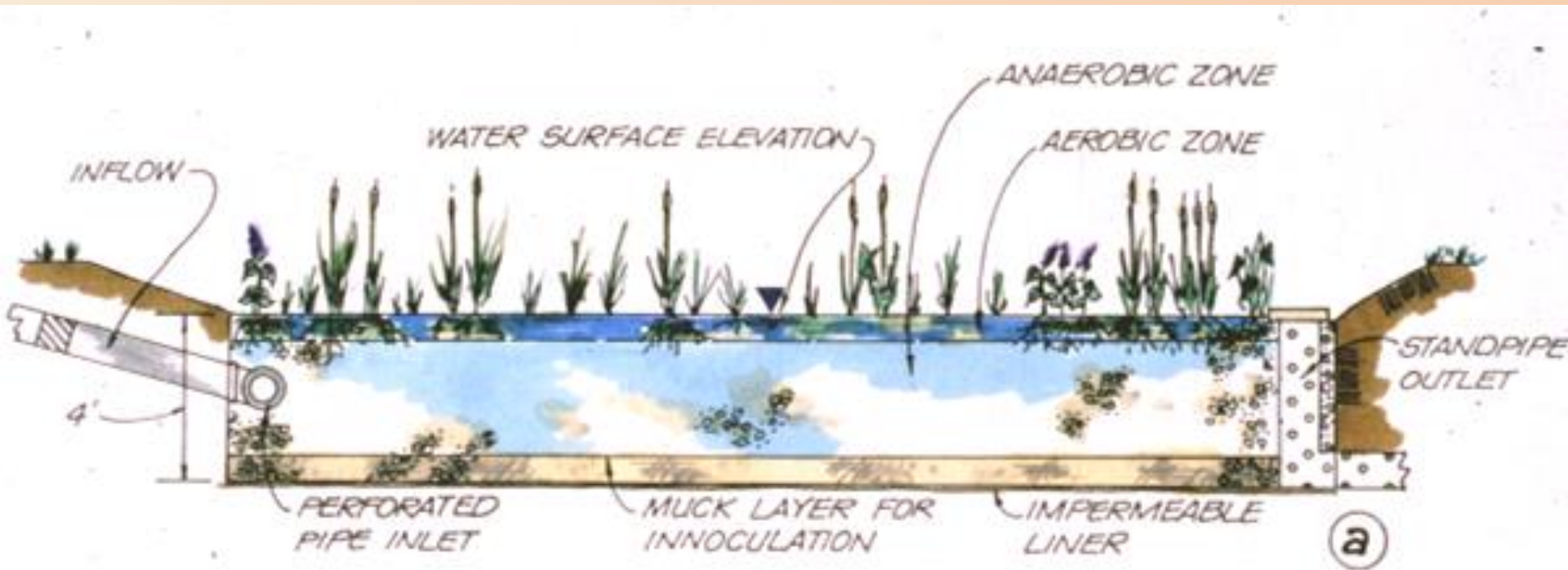


Source: City of Portland, OR



Source: City of Portland, OR

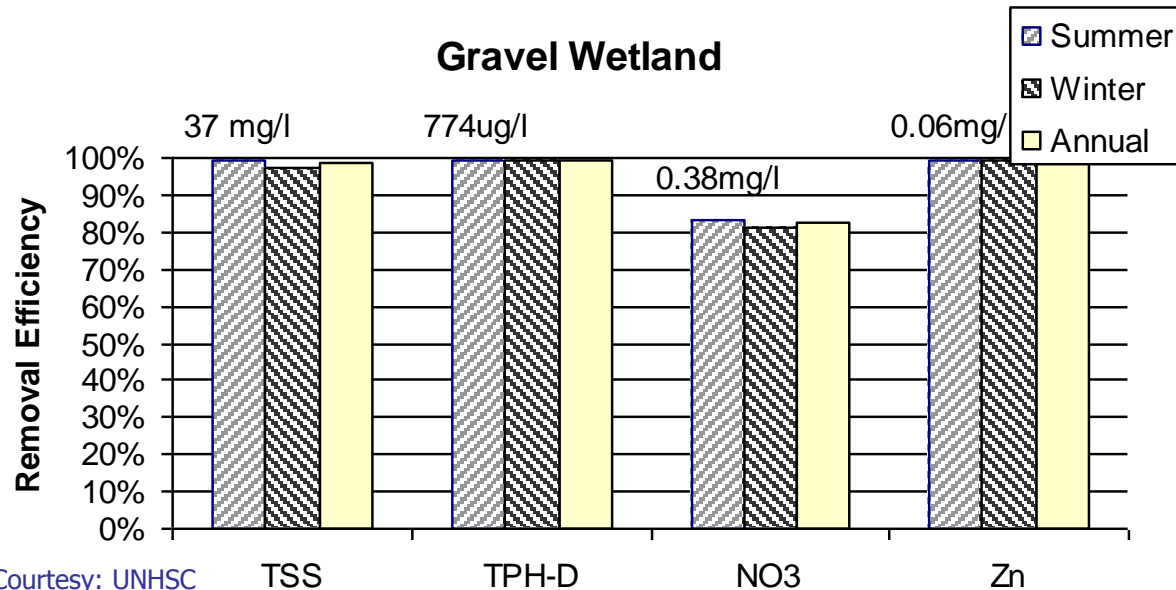
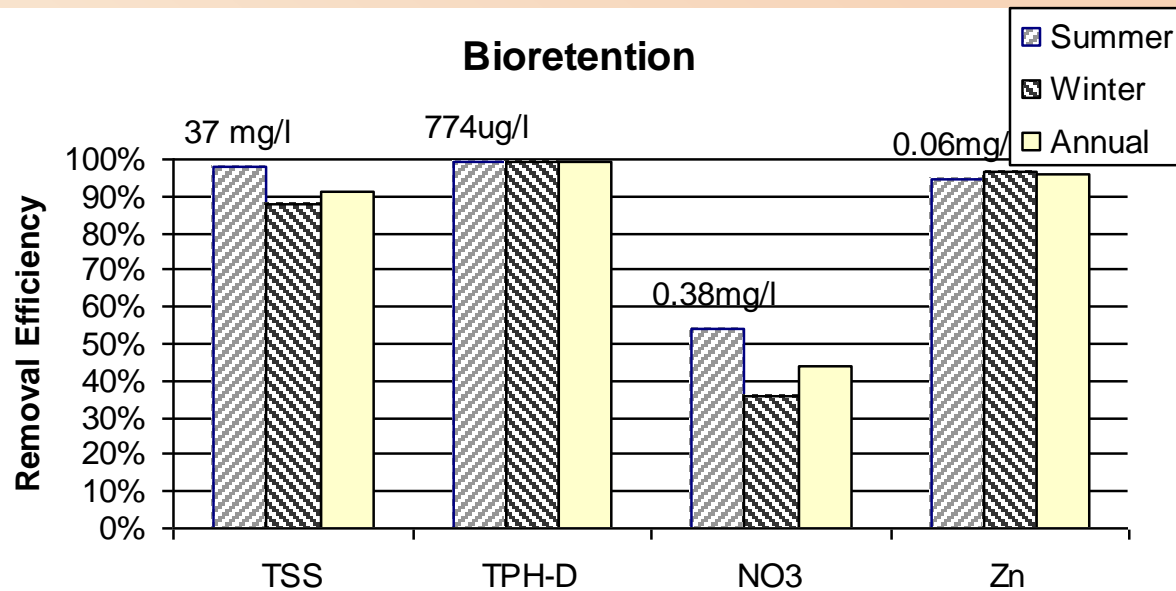
Submerged Gravel Wetland



Copyright 2000, Center for Watershed Protection



Performance Efficiencies



Courtesy: UNHSC

Filtration / Infiltration



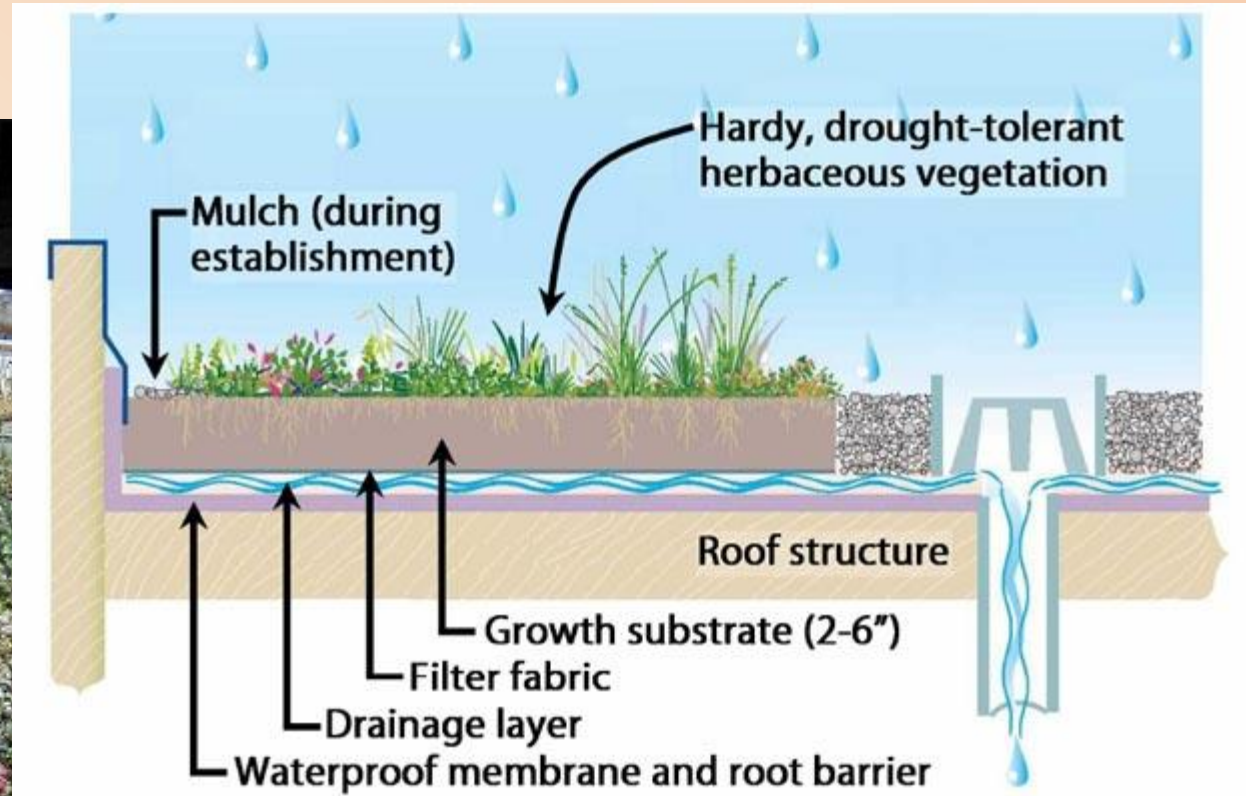
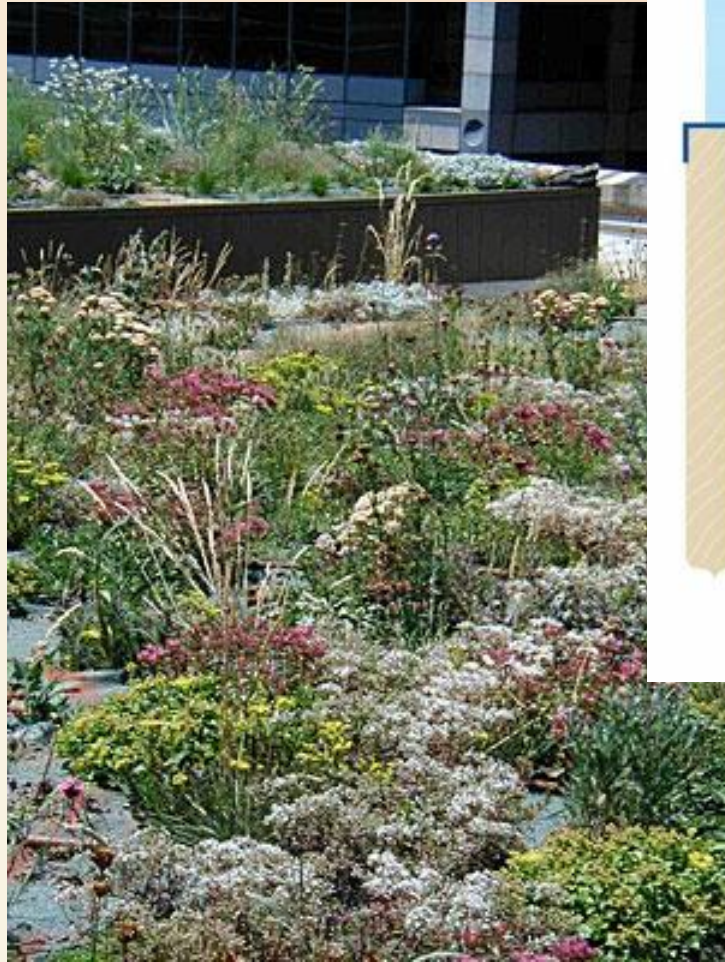
Green Roofs



- Stormwater Runoff absorption/collection
- Reduced flooding of and damage to urban streets
- Interior heating and cooling benefits of 10 degrees or more
- Air purification
- Recreational amenity
- Improved aesthetics
- Extended roof life, estimated at 40 years



Green Roof Systems



Stormwater Planters



- Vegetative uptake of stormwater pollutants
- Pretreatment for suspended solids before they reach water-treatment facilities
- Aesthetically pleasing
- Reduction of peak discharge rate

LID BENEFITS

Environmental and Community

- Protects unique or fragile habitats
- Reduces the pollution impacts of stormwater runoff
- Promotes aquifer recharge
- Provides opportunities to link wildlife habitats
- Conservation values are part of the planning process
- Can further goals of open space and community development plans

The planning process inherently protects natural resources and promotes recharge to underlying aquifers.

Local Authorities

Better Site Design will—

- Identify and preserve natural features
- Maintain natural hydrology
- Help respect abutter's properties
- Retain property values
- Augment groundwater supplies
- Maintain high water quality
- Provide new green space as a amenity

Local Authorities

- Green strips in parking lots provide shade, serve stormwater collection and treatment needs, and reduce the need for large unsightly detention basins
- Reduction in overall parking area reduces runoff volumes
- Shared parking allows for more retail tax revenue
- Enhanced aesthetics can increase retail traffic and sales revenue

Local Authorities

- Infiltration replenishes groundwater supplies, increases aquifer recharge, and maintains base flows to streams and wetlands
- Less runoff and sediment going into public drainage systems = lower maintenance costs, more overall capacity, and a longer lifespan for drainage systems
- Reduced frequency and severity of Combined Sewer Overflow (CSO) events improves water quality and public health

Local Authorities

Vegetated Swales and Filter Strips

- Open channel drainage is a less costly alternative to conventional stormwater drainage system and it provides better treatment
- More visible than enclosed drainage, thus more likely to be maintained
- Enhanced aesthetics may increase property values
- Reduced urban heat island effect lessens cooling costs in the summer and improves air quality

LID BENEFITS

For Developer and Realtor

- Streamlines the plan review process, reduces time and costs
- Adds valuable amenities that can enhance marketing and sale prices
- Decreases site development costs by designing with the terrain

The permitting structure encourages smart growth and facilitates a process that is clear, easy to understand, and cost-effective to developers.

Developer and Realtor

- Green strips in parking lots provide shade and can serve stormwater collection/treatment needs, reducing the size and number of detention basins
- Reduction in overall parking area reduces construction and maintenance costs
- Improved aesthetics help increase lease rates

Developer and Realtor

- Low Impact Development practices can cost less than conventional drainage techniques
- LID can reduce the size and number of detention facilities and the size and cost of drainage infrastructure
- Systems designed to mimic nature can enhance aesthetics and property home values
- Surface vegetative systems are more visible, thereby facilitating routine maintenance and requiring less maintenance than underground practices

Genzyme Corp. Headquarters Cambridge

- Green roof
- Recycled roof runoff for “make up” water for cooling system
- Moisture sensors in green areas to minimize irrigation needs



Olmsted Green, Boston

- Significantly improve existing physical site conditions
- Increase the infiltration of rainfall into soils and groundwater
- Reduce surface flooding
- Protect and enhance wetlands on the property
- Preserve existing mature specimen trees

Olmsted Green, Boston

LID methods will include—

- Tree preservation
- Soil amendments to improve vegetative growth and erosion control
- Vegetated swales and rain gardens
- Subsurface infiltration
- Permeable pavers and pavements
- Stormwater System Operations & Management Plan

Pinehills, Plymouth

- * Small clusters
- * Natural features retained
- * Minimum impervious surfaces
- * Narrow roads



- * Shared driveways
- * Houses sited with natural terrain
- * Vegetation retained



- * Narrow roads
- * "Country drainage"



Key Program Elements for Communities

- Bylaw/regulations that define requirements
- Funding to pay for program components
- Training for staff & consultants
- Inspection and enforcement provisions
- Defined maintenance program
- Long term monitoring program



BMP Maintenance Program

- Establish an **inspection** program
- Provide technical resources and training for **owners** on how to maintain facilities and correct problems
- Provide training for inspection **staff** and maintenance **personnel**
- Established an **enforcement** program
- Provide adequate **funding** thru 1 or more of the following:
 - Aggressive fee structure
 - Impact fees
 - Stormwater utilities
 - Stormwater tax system



LID Model Bylaw

- Provides incentive for conservation site planning
- “Stormwater Credits” reduce the size and number of conventional practices
- Requirement to treat stormwater
- Expands upon Massachusetts Stormwater Policy by including all land areas (beyond Wetland Protection Act jurisdiction)

Model Stormwater Bylaw

1. Purpose and Intent
2. Authority
3. Scope and Applicability
4. Definitions
5. Administration
6. Permit Procedures and Requirements
7. Performance Standards: LID Criteria
8. Enforcement
9. Surety
10. Construction Inspections
11. Certificate of Completion
12. Perpetual Inspection and Maintenance

Appendix A: Example System of LID Credits and Incentives

5.0 Administration

- Administration of the Bylaw designed to utilize existing Boards
- Existing procedures to be used for existing Boards, with the exception of permit submittal and plan requirements

Basic Permit Process

- Each Board/Commission adopts or references the LID Bylaw
- If a project falls within the jurisdiction of an existing Board, the applicant follows the same procedures except for submittal requirements outline in the Bylaw
- The “LID Authority” may designate other Boards/Commissions as authorized agent (with applicant’s concurrence)
- Other Boards/Commissions “signs off” on the permit (if in compliance), and the final “sign off” comes from the “LID Authority”
- If the project does not fall within the jurisdiction of an existing Board, goes directly to “LID Authority”

7.0 Post-Development Stormwater Management Criteria

1. Site Planning Process
 2. No Untreated Discharges
 3. Channel Protection *
 4. Overbank Flooding Protection *
 5. Extreme Flooding Protection *
 6. Recharge
 7. Structural Practices for Water Quality
 8. Water Quality Volume *
 9. Hydrologic Basis for Design of Structural Practices *
 10. Sensitive Areas
 11. Hotspots
 12. LID Credits *
- * Depending on choice, will require a change to current DEP Stormwater Policy

Integrated Stormwater Management Design Objectives

- Runoff reduction
- Groundwater recharge
- Water quality mitigation
- Channel erosion protection
- Overbank and extreme flood protection



Runoff Reduction through Site Design

- Low Impact Development (LID)
 - Longer runoff travel times
 - Series of Integrated Management Practices (IMPs) in drainage network
- Better Site Design
 - Impervious cover reduction and diffusion of runoff
 - Zoning provisions need to be examined
- Conservation Design
 - Strong emphasis on preservation of natural open space



Groundwater Recharge

- Maintain pre-development rates of groundwater recharge to sustain stream/river flows, wetlands, and groundwater levels
- Soils-based approach used in 4 states (curve number approach contemplated)
- Can be achieved by—
 - natural area conservation
 - stream buffers
 - grass channels and swales
 - rooftop disconnection
 - filter strips
 - partial exfiltration - bioretention
 - infiltration



Channel Erosion Protection

- Current dominant criteria (MA Stormwater Policy)—2-year peak flow attenuation
- Several recent stormwater programs recognize the limitations of traditional 2-year control
 - Some utilize 1-year 24-hour Extended Detention (ED) (detention of runoff from the post developed 1 year storm for 24 hours)
 - Some utilize a geomorphic-based criteria such as the Distributed Runoff Control (after, MacRae)

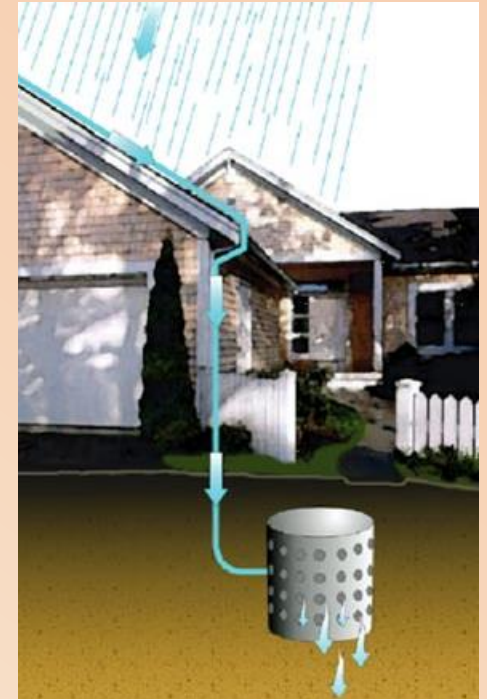
NOTE: 1-year 24-hour ED usually requires more storage than traditional 2-year detention, but also usually meets 2-year control requirements.

Overbank and Extreme Flood Control Criteria

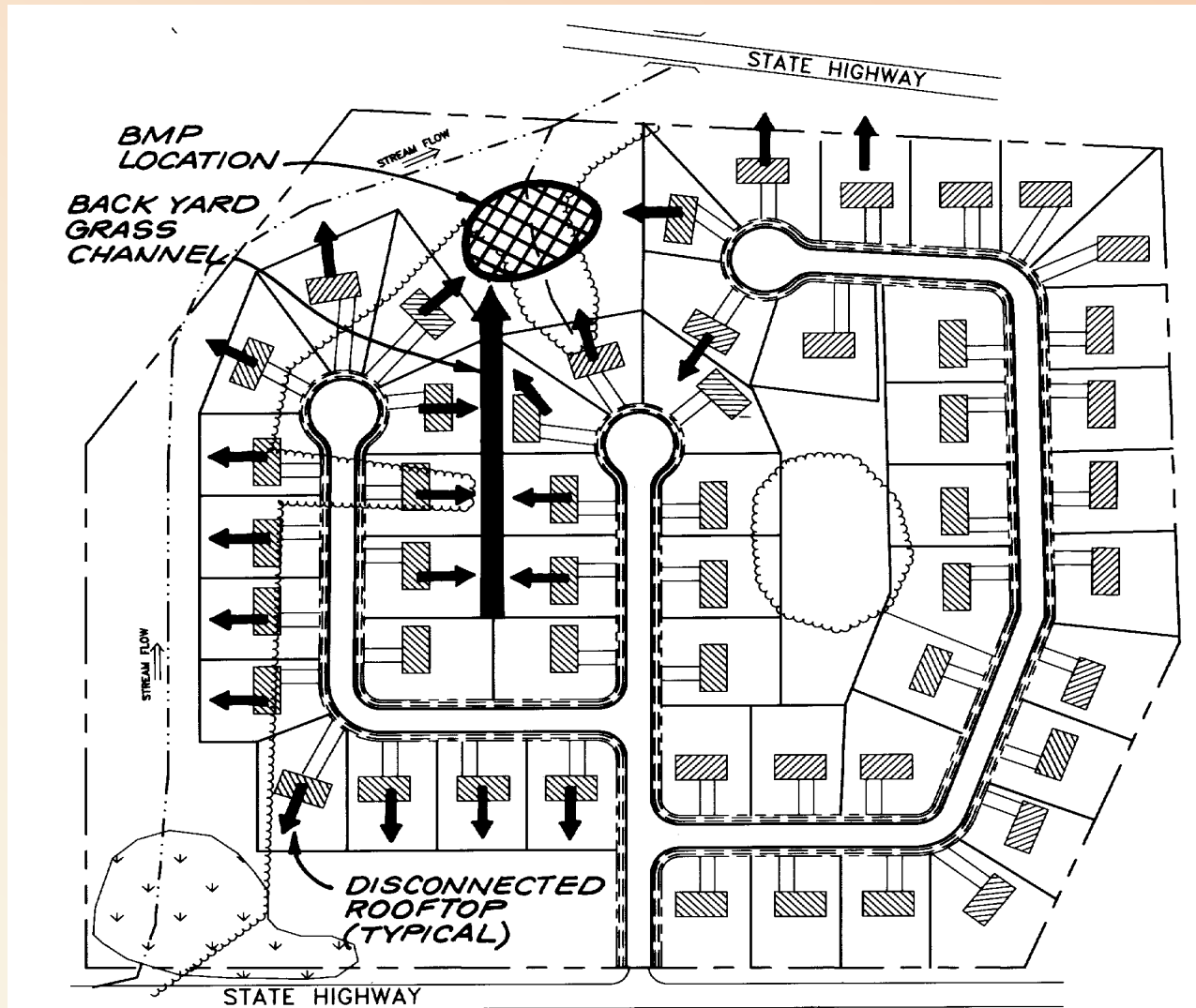
- Standard Approach—
 - 10-year peak flow attenuation (25-, 50-year sometimes)
 - 100-year attenuation or certification of no net downstream impact
- Alternative Approach—
 - No 10-year control, if conveyance system can handle post-dev flows
 - No 100-year control, if established floodplain; or direct discharge to large rivers, lakes or the ocean

Stormwater Credits

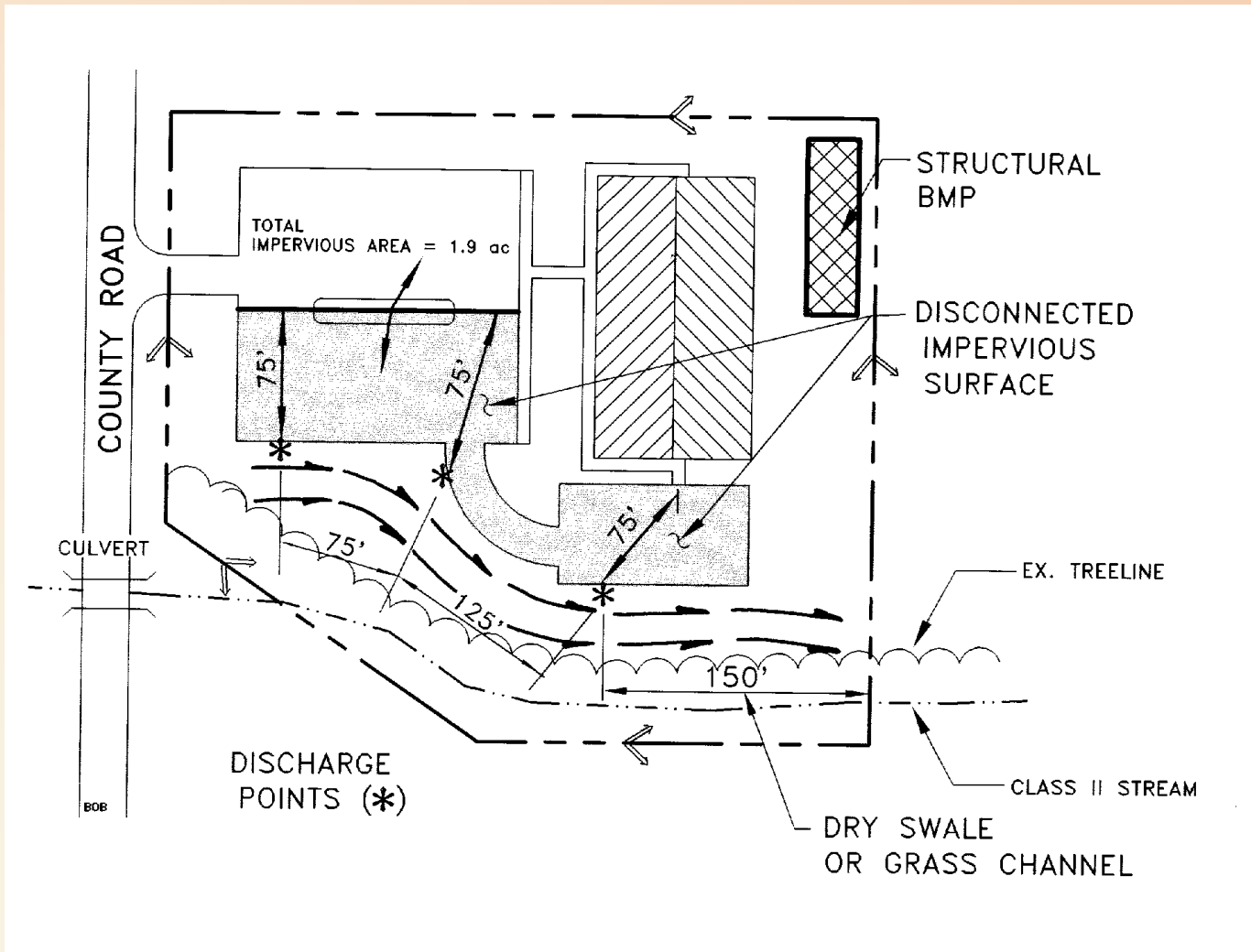
- Set of site design and/or land conservation techniques that reduce traditional stormwater storage requirements—
 - Rooftop runoff disconnection
 - Non-rooftop runoff disconnection
 - Overland flow to riparian/shoreline buffers
 - Open roadside drainage systems
 - Environmentally sensitive single family lot design



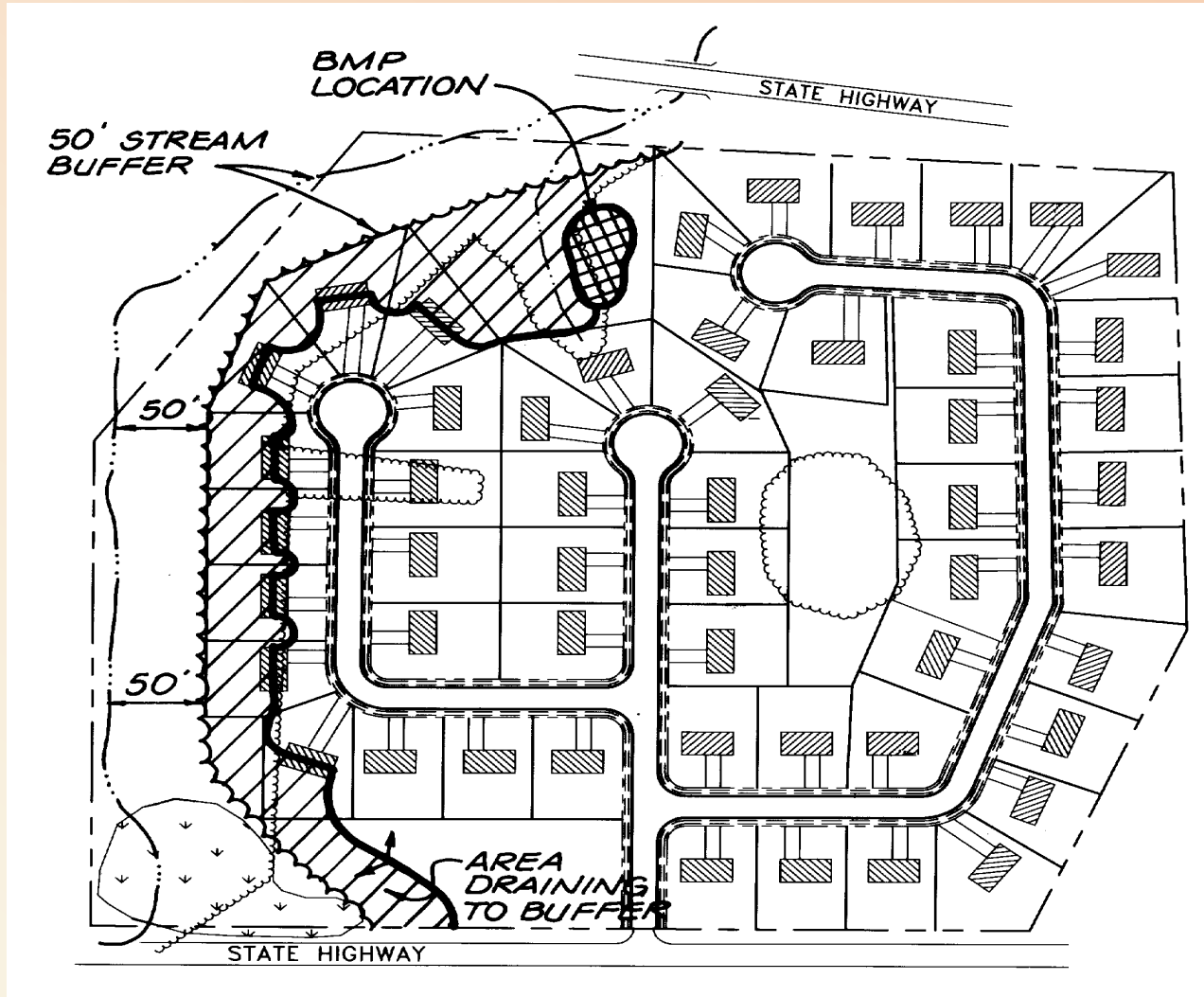
Disconnection of Rooftop Runoff Credit



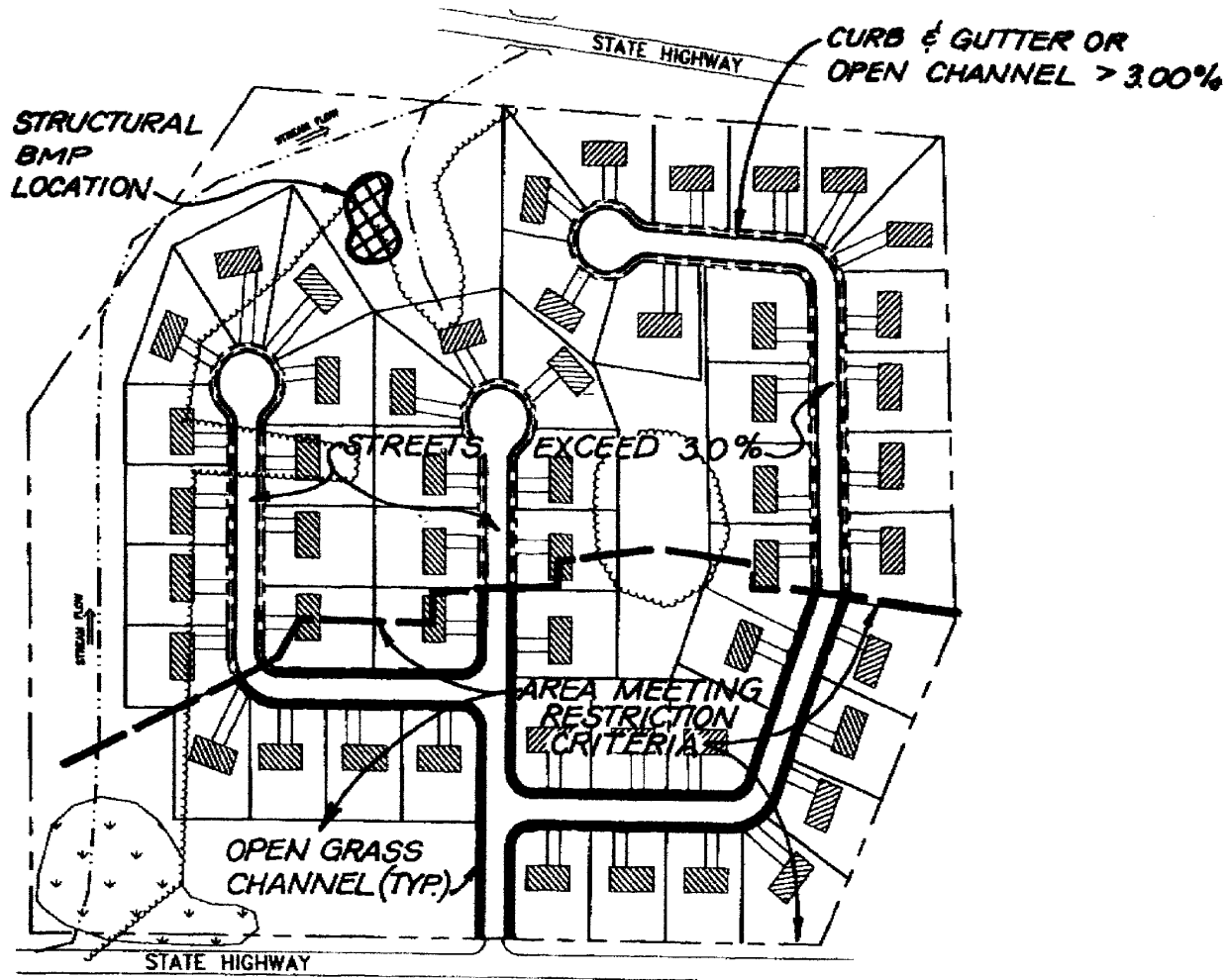
Non Rooftop Runoff Disconnection Credit

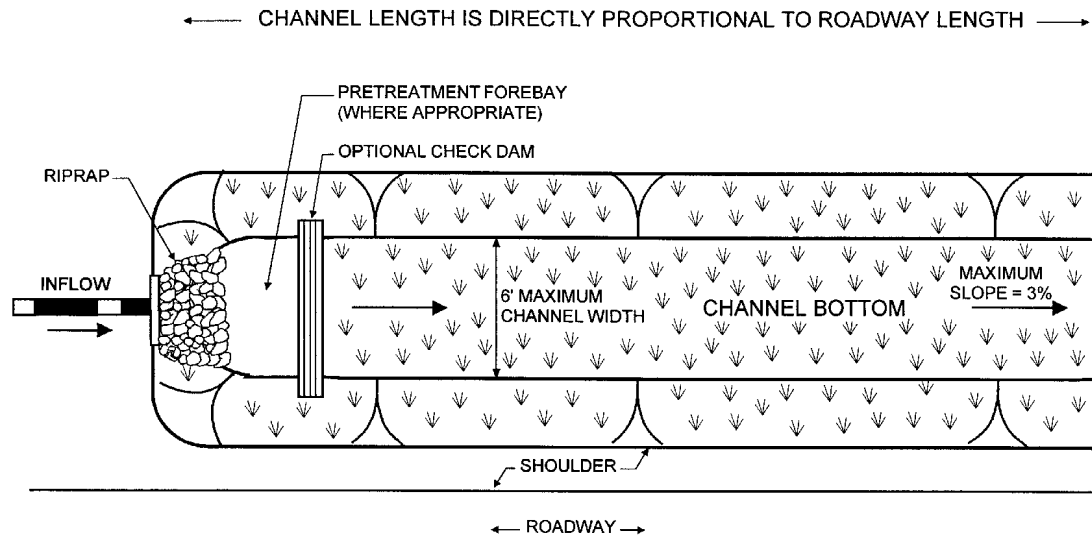


Sheet Flow to Buffer Credit

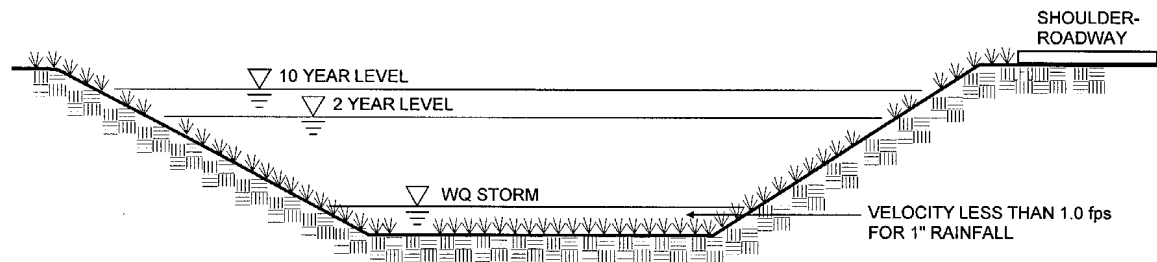


Grass Channels Credit





PLAN VIEW

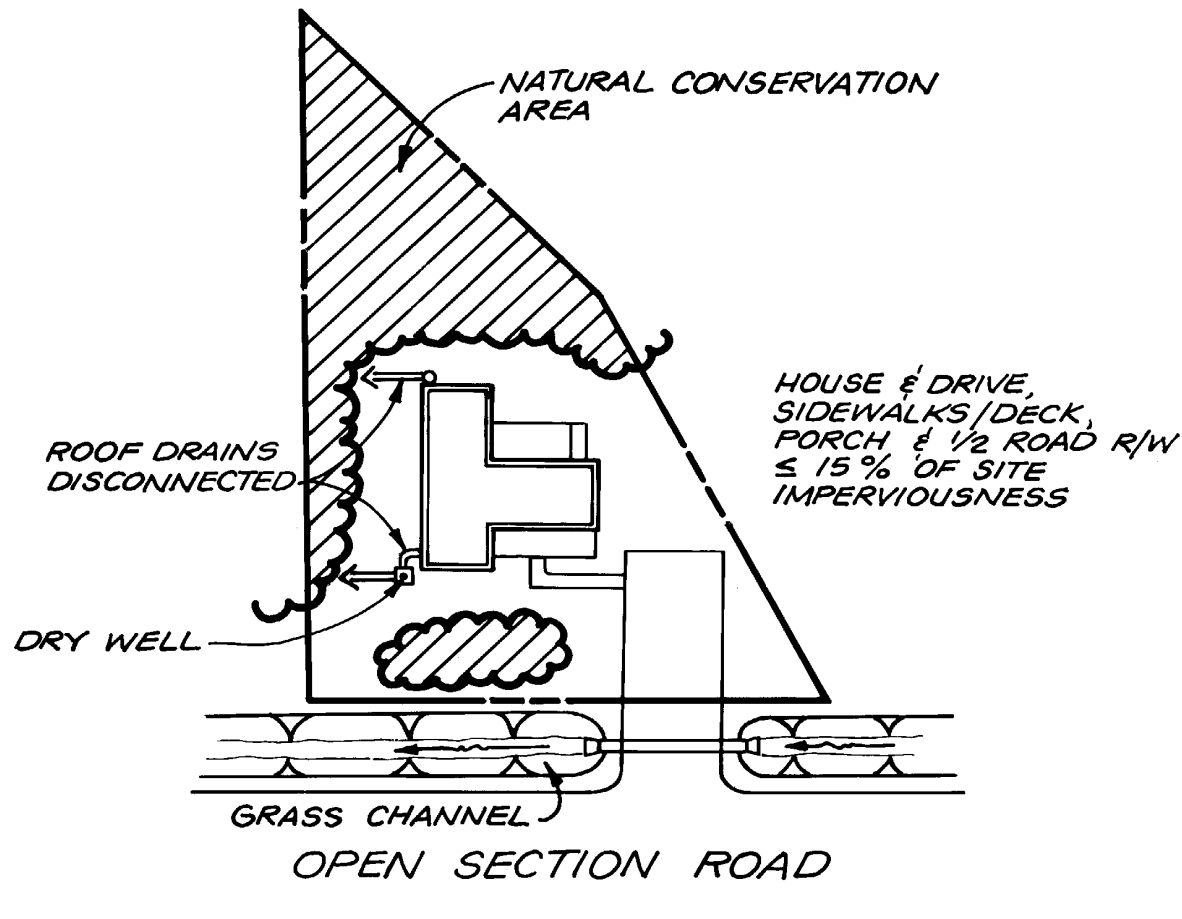


SECTION

Environmentally Sensitive Rural Development Credit

- No recharge or water quality storage required when—
 - Total impervious cover footprint is less than 15%
 - 25 % of site protected in natural conservation areas
 - Rooftop runoff is effectively disconnected
 - Grass channels used for road drainage
 - Stream buffers incorporated where applicable

Environmentally Sensitive Development Credit



Links for More Information

- The Low Impact Development Center
www.lowimpactdevelopment.org
- “Assessing Low Impact Developments Using a Benefit Cost Approach” (PDF), a presentation by Ed MacMullan
www.econw.com/reports/Low-Impact-Development_Benefit-Cost.pdf
- Rooftops to Rivers: Green Strategies for Controlling Stormwater and Combined Sewers Overflows
www.nrdc.org/water/pollution/rooftops/contents.asp
- Low Impact Development, Buzzard’s Bay National Estuary Program
www.buzzardsbay.org/lid.htm
- The University of New Hampshire Stormwater Center
www.unh.edu/erg/cstev/
- Greenscapes
www.nsrwa.org/greenskapes/offers/default.asp

Links for More Information

- Low Impact Development Center: Urban Design Tools
www.lid-stormwater.net/
- Massachusetts Low Impact Development Toolkit, developed by the Metropolitan Area Planning Council (MAPC)
www.mapc.org/LID.html
- Green Roofs for Healthy Cities
www.greenroofs.net/index.php
- Heat Island Effect – Trees and Vegetation
www.epa.gov/hiri/strategies/vegetation.html
- Building Better II: A Guide to America's Best New Development Projects`
www.sierraclub.org/healthycommunities/buildingbetter/